

Hearing Accessibility and Assistive Technology Use by Older Adults: Application of Universal Design Principles to Hearing

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Abstract

Designs for individuals with disabilities in the built environment have focused on removing physical barriers through barrier-free design ideology. Over the past decade, the universal design (UD) movement, which seeks to produce products and environments that are suitable for all individuals to the largest extent possible, has informed building and product standards/policies. UD concepts and their application have largely remained restricted to physical and visual domains. Considerations for universal hearing accessibility and usability in the built environment, by older adults with or without a hearing loss, continue to be deficient. Critical reflections of how acoustic and related designs can enable, impede or change the way individuals participate and engage in various activities in a given space is needed. An interdisciplinary approach was taken by researchers from the fields of human factors, audiology/hearing science, and occupational therapy/science at the University of Western Ontario to examine the applicability of the UD principles to hearing accessibility and usability. A refined list of UD for hearing (UDH) guidelines, their potential relevance to different environments and contextual situations, and their implications for assistive technology use by older adults is presented and discussed. A case study is used to illustrate the use of the UDH guidelines to assess the impact of environments and technology use for older adults.

Introduction

An interdisciplinary team of researchers in hearing science, audiology, occupational science, occupational therapy, ergonomics and human factors as well as consumers, came together to critically analyze the literature on accessibility and to develop a guide for creating and evaluating hearing accessible spaces based on principles of Universal Design (UD). An interdisciplinary approach was taken to examine the applicability of UD principles to hearing accessibility and usability (Fok, Shaw, Jennings, & Cheesman, 2007; 2009). This paper introduces the principles of Barrier-Free Design, Universal Design (UD); a guideline developed by the interdisciplinary team for UD for Hearing (UDH), and highlights the implications of UDH for examining hearing accessibility and technology use by older adults using a case study.

Existing Approaches to Support Accessibility and Usability: Barrier-Free Design and Universal Design Ideology

Existing approaches to support accessibility and usability include Barrier-Free Design and Universal Design ideologies. Traditionally, designs for persons with disabilities have focused on removing physical barriers through Barrier-Free Design Ideology.

Barrier-Free Design Ideology

Barrier-free designs usually focus on specialized designs and/or adaptations that are specific to the disability of concern: the greatest focus has been on physical barriers and to a lesser extent visual barriers. According to the Accessibility Directorate of Ontario (2005), a barrier is,

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“...anything that prevents a person with a disability from fully participating in all aspects of society because of his/her disability, including physical, architectural, informational, communication, attitudinal, technological barriers, policies or practices.” Barrier-free, “...means that a building and its facilities can be approached, entered, and used by persons with physical and sensory disabilities” (Ministry of Municipal Affairs & Housing, 2006). Barrier-free design takes an individualized approach to accommodating needs. Current technological approaches to enable hearing focus on the provision and use of personal devices such as infrared (IR) or frequency-modulated (FM) systems, and amplified telephones, that are used without or in conjunction with personal hearing aids. For example, an IR system may be installed in a theatre and the person who wishes to use it is required to borrow a receiver/headset from the theatre.

A Barrier-free Design Example

Mrs. Smith is a 65 year old binaural hearing aid user. Mrs. Smith enjoys going to the theatre with friends, but has stopped going recently due to difficulties hearing in the theatre. She reports this difficulty to you (her hearing health care professional) and you ask her if she is aware that an IR system was available for use? She is not aware of this. You proceed to talk to her about the process for borrowing a headset in the theatre. Then, you spend time orienting her to the device and how to use it after removing her hearing aids. Mrs. Smith calls the theatre, reserves tickets and reserves an IR headset. Mrs. Smith arrives at the theatre with her friends and picks up the headset from the person at the coat check desk. She takes the headset into the theatre, removes her hearing aids and puts the headset on. She is unable to speak with her friends while she has her hearing aids out and the headset on. At the intermission, Mrs. Smith removes the headset and puts her hearing aids on. She gets in line, orders and purchases a glass of wine. She moves away from the concession area and finds her friends amongst the conversation-filled lobby area. She then attempts to contribute to the conversation her friends are having. Once the intermission is over, Mrs. Smith enters the theatre, finds her seat, removes her hearing aids and puts the headset on. Once again she is unable to speak with her friends while she has her hearing aids out and the headset on. When the play finishes, she once again removes the headset, puts her hearing aids in. She then attempts to follow and contribute to the conversation her friends are having, along with every-

one else, as they move through the theatre into the lobby area. She returns the headset to the coat check desk and leaves the theatre.

As highlighted in this example, going to the theatre can be a highly complex process for an older adult hearing aid user and many barriers remain within environments and with technologies that are informed by barrier-free design.

Universal Design (UD) Ideology

The concept of UD has inspired professionals to think beyond the boundaries of barrier-free design. UD supports the design of products and buildings to be usable by all people to the greatest extent possible without special adaptations (Mace, Hardie, and Place, 1991). The principles of UD have had a tremendous impact, especially in housing and product design and have fostered considerations for design for persons with a wide range of abilities.

There are seven principles of Universal Design (The Centre for Universal Design, 1997). The first principle is “Equitable Use. The design is useful and marketable to people with diverse abilities.” The design of an environment and/or a product should be identical or equivalent for all users, regardless of their abilities. The individual should not be segregated or stigmatized in using the product or the environment, and all users should have the same level of privacy, security and safety in the environment and/or when using the product. The second principle is “Flexibility in Use. The design accommodates a wide range of individual preferences and abilities.” The individual should have a choice in how they use the environment or product, the product they would prefer to use within a particular environment, and the environment or product should ensure precision and accuracy on the part of the user. The third principle is “Simple and Intuitive Use. Use of the design is easy to understand regardless of the user’s experience, knowledge, language skills, or current concentration level.” The design of the environment and/or product should not be complex and should be simple and intuitive to use. The user should receive prompting and feedback during and after use of the environment or the product. The fourth principle is “Perceptible Information. The design communicates necessary information effectively to the user, regardless of ambient conditions or the user’s sensory abilities.” Information in the environment, or related to the product should be easily accessed by the user regardless of the other conditions in

the environment or the sensory abilities of the individual. This includes redundant presentation of information in different modalities, instructions/directions that are easily communicated, and products that are compatible with a variety of devices that may be used by the individual. The fifth principle is, "Tolerance for error. The design minimizes hazards and the adverse consequences of accidental or unintended actions." The design of the environment and/or product should reduce the possibility of and provide warnings of potential errors and hazards. The sixth principle is, "Low physical effort. The design can be used efficiently and comfortably and with a minimum of fatigue." The design of the environment and/or product should minimize the need to repeat actions and the need for ongoing physical effort. The seventh principle is, "Size and space for approach and use. Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility." The design of the environment or product should ensure that the user can see, reach and manipulate equipment and controls comfortably and that the user can easily see what they need to within the environment.

In the case of Mrs. Smith, as described above, it is evident that consideration of UD principles further highlights the complexity of the theatre experience, but also provides a framework within which to consider the design of environments and products that facilitate hearing accessibility.

UD design concepts and their application have largely remained restricted to physical and to visual domains. Research in UD related to hearing has focused on the development of electronic materials and distance education for persons who are hard of hearing or Deaf (e.g. Berent, 1996; Erath & Larkin, 2004; Obrenovic, Abascal & Starcevic, 2007). One study looked at access within a model UD building for participants with vision, mobility and hearing impairments (Danford, 2003). The study did not look at communication demands that may take place within the environment and thus results suggested there was little impact for the person with hearing loss. The Canadian Hard of Hearing Association (2008) published a document titled, "Universal Design and Barrier Free Access: Guidelines for Persons with Hearing Loss." This document is an appropriate technical and solutions-based resource that provides an overview of acoustic and visual conditions as well as a discussion of traditional hearing assistive technologies, but the greatest emphasis is on barrier-free rather than UD.

In summary, we continue to see an individualized ap-

proach to accommodate needs. Hearing demands and requirements related to the daily lives of older adults have not been adequately investigated or addressed. Currently, a comprehensive approach for considering what, how, where and with whom people conduct activities that require hearing is lacking. We believe there is a need for a companion guideline to the original UD principles as it related to hearing. We propose a more comprehensive approach that integrates concepts and perspectives from occupational science to complement and build on current knowledge on accessibility and usability.

Using an Occupational Perspective to Promote Universal Design Principles for Hearing

While an individual approach, such as that used in barrier-free design, is an important component of accessibility, a more comprehensive approach to address the hearing needs of persons across the spectrum of what they do on a daily basis is lacking. Within occupational science, "occupation" is defined as the engagement or participation in a recognizable life endeavour. An occupation approach is focused on what people do, need to do, and want to do in community and public environments, as well as what constrains participation. An occupational approach considers the complexity of interactions between the person, the environment, the occupation/activity and objects (Hocking, 1994; Law et al., 1996). Assessment of participation and performance must include an examination of the processes and contexts that support them. Using an occupational approach involves making a detailed description of the activity itself, the demands, requirements and available resources to support individuals or groups in a specific environment. Barriers and facilitators within the immediate environment, the community and social contexts are examined to assess the degree and quality of participation as well as opportunities for change. This approach can provide a foundation for critically examining how environments support or hinder hearing accessibility and usability for persons in the community.

Using an occupational approach requires us to gain an in-depth understanding of the contexts and available resources for change. Contexts that underscore productivity for persons with diverse abilities include micro, meso, and macro level contexts (Fok, Shaw, Jennings, & Cheesman, 2009). Micro level contexts refer to the places and physical spaces where activities occur. The meso level context refers to the characteristics or nature

of the activities, i.e. the culture and procedures. This level includes how activities are normally carried out, established ways of doing things and communicating with others, safety and security issues that may or may not be conducive to change. The macro level context refers to the governance, policy, legislation, economics that support or undermine activities.

In summary, at the micro level, we need to consider what is in the space and what people need to do within the space. In the case of Mrs. Smith, the space is the theatre, the theatre has an IR system, Mrs. Smith needed to interact with theatre staff, borrow and use the IR system receiver to hear the production. Mrs. Smith also needed to communicate with her friends in the theatre and in the lobby. At the meso level we need to consider how people conduct activities within the constraints of the environment, culture and established procedures. In the case of Mrs. Smith, use of the IR system may have made her feel that she was segregated from her friends and stigmatized for wearing the receiver and not being able to converse with her friends. Others at the theatre who do not have experience with IR systems may have wondered why she was wearing a headset and may also have wondered about the purpose of the headset. Mrs. Smith needed to switch from the headset to using her hearing aids at the intermission, as well as working hard to ensure that the natural flow of conversation with her friends was not impeded in the noisy theatre lobby. Difficulty in following the conversation, asking for repetition, may be considered by others to be out of pace with how conversations are normally conducted in public places. And, at the macro level we need to consider the factors within the environment that may or may not be conducive to change and the availability of resources to support change. At this level, accessibility legislation and participation of Mrs. Smith on her city's access committee and/or the theatre's fundraising committee would support her community to be more sensitive and responsive to the needs of older persons with hearing loss.

Keeping an occupational approach as a foundation, our team identified themes within the original UD principles that we believed were particularly relevant to activities that involve hearing. These themes were then written into 5 UDH guidelines (Fok, Shaw, Jennings, & Cheesman, 2007; 2009). We then visited a number of public spaces and used the guidelines as a basis for describing hearing access in these environments. This led to further refinement of the guidelines. The UDH guidelines are not a list of technical and environment adaptations and they are not meant to provide specific solu-

tions. These guidelines are not exclusive and there may be overlap between aspects of the guidelines. We hope that the guidelines will allow a better appreciation of accessibility and usability concerns as they relate to occupations requiring hearing. The current 5 UDH guidelines are described below.

The first UDH guideline, *optimize hearing environment* for all, is related to the original UD principle of "Equitable Use". Hearing environments should maximize the capabilities of a person to hear with or without their current hearing assistive technologies and not segregate or stigmatize users of the environment. The design of the environment should benefit most, if not all individuals to hear better regardless of their hearing abilities. Three critical aspects of the environment include optimizing reverberation time and reverberation characteristics, minimizing background noise levels, and maximizing intelligibility.

The second UDH guideline is to *optimize interactions between persons and objects to promote better hearing in an environment*. Hearing environments should maximize the capabilities of a person to hear desired sounds while minimizing unwanted noises from objects in the environment. Desirable sounds should be maximized while unwanted noises from objects should be minimized. There is a need to evaluate how objects in the environment interact to shape the environment that is or is not suitable for activities that involve hearing, to consider the positioning and maintenance of objects, and the relative distance between persons and desired and unwanted sources of sound.

The third UDH guideline is to *optimize the opportunities for people to have multiple choices of interactions* with one another. There is a need to consider environments that maximize the capabilities of people to hear within many forms of interpersonal interactions including but not limited to one-to-one, one-to-many, many-to-one. There is a need to consider the dynamic and sometimes faced-paced nature of what occurs within various environments.

This fourth UDH guideline *optimize opportunities for people to perform different activities in and across environments*. There is a need to consider environments that maximize the capabilities of people to hear within single- or multiple-hearing activities. The design or the redesign of the environment needs to consider different configurations of an area to allow for a variety of desired, expected and unexpected activities to be performed.

The final guideline includes the original UD principles of "Simple and Intuitive Use", "Tolerance for Error"

and “Low Physical Effort”. The fifth UDH guideline is to *optimize opportunities for people to use the environment without extra steps for hearing access, during preparatory, use and/or after use phases*. There is a need to consider environments that maximize occupational equality as it relates to access and usability between persons with and/or without hearing loss, before, during and after an activity that involves hearing. In addition, the environment should *optimize the opportunity for people to have safe, private and secure use of the environment while minimizing distraction, interference, or cognitive loading*. There is a need to consider environments that maximize occupational equality between persons with and/or without a hearing loss as it relates to safe, private and secure use of the environment with minimal distraction, interference or cognitive loading. Designs of environments should be seamless. The person should be able to walk in and hear the necessary information without expending considerable cognitive or physical effort.

The following is a description of Mrs. Smith and a theatre experience that addresses some of the issues raised in the UDH guidelines.

A Universal Design for Hearing (UDH) Example

Mrs. Smith is a 65 year old binaural hearing aid user. Mrs. Smith enjoys going to the theatre with friends, but has stopped going recently due to difficulties hearing in the theatre. She reports this difficulty to you (her hearing health care professional) and you ask her if she is aware that the theatre has a communication system that would be compatible with her personal FM system? She is not aware of this. You proceed to talk to her about how the theatre has a wide-area transmitter that will send the audio signal from the performance on stage wirelessly to her hearing aids via her personal FM receivers. In addition, she will not have to worry whether she is on the correct radio frequency to hear the performance as there is a wall-mounted device by the entrance of the theater to ensure her FM receivers are synchronized to the correct frequency. Mrs. Smith simply has to walk by the device as she enters the theatre and the device will adjust her FM receivers, temporarily, to the correct frequency to enjoy the performance. You also tell Mrs. Smith that if she has her hearing aids switched to the MT program, she will be able to hear the person she is sitting with in the theatre. Mrs. Smith calls the theatre and reserves the tickets for the opera. Mrs. Smith

arrives at the theatre with her friends. She and her friends move into the theater to take their seats. Mrs. Smith notices her hearing aids “beep” as she walks through the entrance to the theatre and notes that her FM receivers must have been automatically adjusted so she can use the theatre’s FM system. She is able to speak with her friends while she waits for the performance to begin. Mrs. Smith is able to hear the performance as well as comments made by her neighbour in the theatre. With surtitles (lyrics and dialogue translated and projected on a screen above the stage), Mrs. Smith is also able to read lyrics and dialogue to supplement what she hears during the performance. At the intermission, she gets in line, orders and purchases a glass of wine. She moves away from the concession area and finds her friends amongst the conversation-filled lobby area. She then switches her hearing aids to directional mode and is able to follow and contribute to the conversation her friends are having. Once the intermission is over, Mrs. Smith enters the theatre, finds her seat. Once again she is able to hear the performance, read lyrics and dialogue and hear comments made by her neighbour in the theatre. When the opera finishes, she is able follow and contribute to the conversation her friends are having as they move through the theatre into the lobby area. They leave the theatre together and continue their conversation outside of the theatre.

As highlighted in this example, going to the theatre is a much less complex process for an older adult hearing aid user when environments and technologies are informed by an occupational approach and UDH guidelines.

Discussion and Summary

This paper introduced participants to existing approaches to support accessibility and usability, i.e. Barrier-Free Design and Universal Design ideologies. This paper introduced an occupational perspective to promote UD concepts to hearing and five UDH guidelines. This paper also described how knowledge from occupational science can complement the hearing sciences, and the accessibility and usability literature to present a more comprehensive approach to consider the complexity of interactions between persons, environments, objects in the environment, the activities in which persons need to engage and barriers and facilitators to participation.

Within a UDH approach, there is a global consider-

ation of hearing in the environment and this is essential for the promotion of hearing environments that are suitable for most people including older adults with hearing loss. There is a need to better understand the hearing abilities of adults as they age along with associated issues, such as awareness and disclosure. This knowledge will assist us in identifying barriers and challenges for older adults in performing activities that involve hearing in a safe and productive manner. With this knowledge there is a need to identify and consider barriers and resistance to change that may impede the design of environments and installation of products for older adults, such as attitudes towards aging and hearing loss, and tolerance and acceptance of diversity. These considerations can then assist us to work towards identifying potential opportunities and resources for change within the micro and meso level contexts. Opportunities to change accessibility and usability to meet the transitional needs of older adults with hearing loss may also feed back to benefit others. We hope that this work offers new insights into strategies to assist us in achieving compliance with disability and human rights guidelines and standards developed to protect the rights of older adults with hearing loss.

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